

## **CLAIMS**

**We claim:**

- 1   **1. A method for operating a Picosecond Imaging Circuit Analysis (PICA)/ high**  
2   **current source system comprising:**  
3         **applying pulses from a high current pulse source to a Device Under Test**  
4   **(DUT);**  
5         **employing a photosensor means for detecting photon emissions from said**  
6   **DUT;**  
7         **receiving signals from said photosensor means to map photon emissions from**  
8   **said DUT; and**  
9         **employing data processing means for relating said photon emissions to**  
10   **specific features of said DUT.**
- 1   **2. The method of claim 1, including high current source means for generating a**  
2   **pulse train which increases in amplitude with time.**
- 1   **3. The method of claim 2, wherein said pulse train is periodic or aperiodic.**
- 1   **4. The method of claim 3, wherein where said pulse train is an ElectroStatic**  
2   **Discharge (ESD) event selected from the group consisting of a Human Body Model**  
3   **(HBM), a Machine Model (MM), a Charged Device Model (CDM), a Reverse**  
4   **Charge Device Model (RCDM), a Socketed Device Model (SDM), a Charged cable**  
5   **Discharge Event (CDE), and a Transmission Line Pulse (TLP).**

1    **5. The method of claim 1 comprising the steps as follows:**  
2           **providing a current probe to measure current in said DUT;**  
3           **providing a voltage probe to measure voltage in said DUT;**  
4           **providing a leakage measurement means for evaluation of a device;**  
5           **providing a photon signal collection process in time from said device;**  
6           **providing a step increase in the high current pulse source amplitude after**  
7   **adequate emission data is established;**  
8           **providing a Computer Aided Design (CAD) system to visualize the emissions**  
9   **on the chip mapping;**  
10          **providing a means to store voltage, current, leakage and photon emissions**  
11   **from said device;**  
12          **providing an averaging means of voltage, current, leakage, and photon**  
13   **measure;**  
14          **providing a means of visualization of a photon intensity spatially;**  
15          **providing a means to plot voltage, current, leakage an a measure of photon**  
16   **emissions from said device; and**  
17          **whereby high current pulse and picosecond imaging circuit analysis is**  
18   **provided.**

1    **6. A method for evaluation of photon emissions and high current robustness of a**  
2    **semiconductor chip comprising the steps as follows:**  
3            **providing electrical signals to pads of said semiconductor chip;**  
4            **eliminating power supply D.C. voltage levels to said chip to set said chip into**  
5    **an unpowered state;**  
6            **providing a pulse train source producing pulses with a fixed pulse width and**  
7    **fixed rise and fall times for a pre-determined pulse current magnitude into said**  
8    **pads of said semiconductor chip;**  
9            **providing filtered light emissions by filtering light emissions of a first**  
10   **frequency range from said semiconductor chip;**  
11           **collecting said filtered light emissions and determining an adequate number**  
12   **of pulses to provide adequate signal magnitude for analysis;**  
13           **evaluating functionality of said semiconductor chip to evaluate parametric**  
14   **shifts or destruction;**  
15           **increasing said current magnitude of said pulse train and repeating**  
16   **above-mentioned steps until destruction of said semiconductor chip; and**  
17           **repeating all the above steps with a second filter frequency range.**

1    **7. The method of claim 6 wherein said pulse train source provides pulses with a**  
2    **plurality of pulse widths.**

1    **8. The method of claim 6 wherein said pulse train source provides pulses with a**  
2    **plurality of pulse rise times.**

1    **9. The method of claim 6 wherein a filter is used to determine electron-hole pair**  
2    **recombination.**

1    **10. The method of claim 9 wherein said filter is used to determine avalanche**  
2    **breakdown.**

1     **11. The method of claim 9 wherein said filters are rg780 and bg39.**

1     **12. A method of providing a picosecond imaging circuit analysis / high current**  
2     **source system and emulator comprising the steps as follows:**

3             **providing a high current pulse source;**

4             **providing a photon signal collection process in time;**

5             **providing a step increase in the high current pulse source amplitude after**  
6     **adequate emission data is established;**

7             **providing a Computer Aided Design (CAD) system to visualize the emissions**  
8     **on the chip mapping;**

9             **providing an electrothermal circuit simulation;**

10            **providing a post-processor to generate the photon emission rate;**

11            **providing a emulated mapping of said photon collection process in time; and**

12            **providing a comparator between said actual photon mapping and said**  
13     **emulated photon mapping.**

1     **13. A computer program product comprising a computer useable medium having**  
2     **computer readable program code embodied therein for operating a picosecond**  
3     **imaging circuit analysis / high current source system, the program product**  
4     **comprising:**

5            **a) program code configured to provide a high current pulse source;**

6            **b) program code configured to employ a photosensor means for detecting photon**  
7     **emissions from a device under test;**

8            **c) program code configured for receiving signals from said photosensor means to**  
9     **map photon emissions from said DUT; and**

10            **d) program code configured for employing data processing means for relating said**  
11     **photon emissions to specific features of said DUT.**

1    **14. The computer program product of claim 13 including program codes**  
2    **configured to operate high current source means for generating a pulse train which**  
3    **increases in amplitude with time.**

1    **15. The computer program product of claim 14 including program codes configured**  
2    **to said pulse train are periodic or aperiodic.**

1    **16. The computer program product of claim 15 including program code configured**  
2    **whereby said pulse train is an ElectroStatic Discharge (ESD) event selected from the**  
3    **group consisting of a Human Body Model (HBM), a Machine Model (MM), a**  
4    **Charged Device Model (CDM), a Reverse Charge Device Model (RCDM), a**  
5    **Socketed Device Model (SDM), a Charged cable Discharge Event (CDE), and a**  
6    **Transmission Line Pulse (TLP).**

1    **17. A picosecond imaging circuit analysis / high current source analysis apparatus**  
2    **comprising:**  
3        **a high current source means for applying a pulse to a Device Under Test**  
4    **(DUT);**  
5        **photosensor means for detecting photon emissions from a DUT;**  
6        **a data acquisition circuit for receiving signals from said photosensor means**  
7    **for mapping of photon emissions from said DUT; and**  
8        **data processing means connected to said data acquisition circuit for relating**  
9    **said photon emissions to specific features of said DUT.**

1    **18. The apparatus of claim 17, wherein said high current source means generates a**  
2    **pulse train which increases in amplitude with time.**

1    **19. The apparatus of claim 18, wherein said pulse train is periodic or aperiodic.**

1    **20. The apparatus of claim 19 wherein where said pulse train is an ElectroStatic**  
2    **Discharge (ESD) event selected from the group consisting of a Human Body Model**  
3    **(HBM), a Machine Model (MM), a Charged Device Model (CDM), a Reverse**  
4    **Charge Device Model (RCDM), a Socketed Device Model (SDM), a Charged cable**  
5    **Discharge Event (CDE), and a Transmission Line Pulse (TLP).**

1    **21. The apparatus of claim 18, wherein an algorithm is provided to relate said**  
2    **photon emission to said power to failure.**

1    **22. A high current pulse electrical and picosecond imaging circuit analysis**  
2    **comprising:**  
3           **a pulse source;**  
4           **a transmission line cable from the said pulse source to a structure with a high**  
5    **voltage switch connected in said transmission line cable;**  
6           **an oscilloscope;**  
7           **a current probe;**  
8           **a voltage probe;**  
9           **a leakage measurement source;**  
10          **photo-detector array;**  
11          **a data-acquisition system connected for collecting data from the imaging**  
12    **detector and data including oscilloscope voltage and current signals, leakage**  
13    **measurements; and**  
14          **means for providing visualization of photon emissions in time.**

1    **23. An apparatus to emulate a picosecond imaging circuit analysis / high current**  
2    **source analysis apparatus comprising:**  
3           **a high current source forming a pulse train;**  
4           **a collection source for evaluating photon emissions;**  
5           **a computer aided design (CAD) system for visualizing chip mapping;**  
6           **an electrothermal circuit simulator;**  
7           **a post-processing system for calculating photon emission from a circuit**  
8    **simulator; and**  
9           **a second computer aided design (CAD) system for visualizing emulated**  
10   **photon emissions from said post-processing system.**

1    **24. The apparatus of claim 23 wherein said system provides a filter for emission**  
2    **energy for said first and said second CAD systems.**

1    **25. The apparatus of claim 23 wherein a comparator system compares an actual**  
2    **photon emission map from said first computer aided design (CAD) system from the**  
3    **photon emissions, and from said second computer aided design (CAD) system from**  
4    **an emulated photon emission map.**

1    **26. The apparatus of claim 25 wherein said system provides a filter for emission**  
2    **energy for said first and said second CAD systems.**

1    **27. The apparatus of claim 23 wherein a third CAD system provides the means to**  
2    **calculate current and voltage on a given node from said photon emission mapping**  
3    **whose results are compared to said electrothermal circuit simulation results.**